Section 2

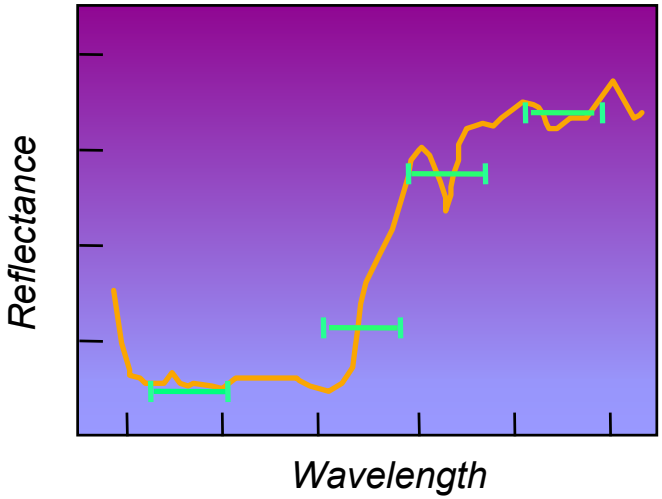
Hyperion

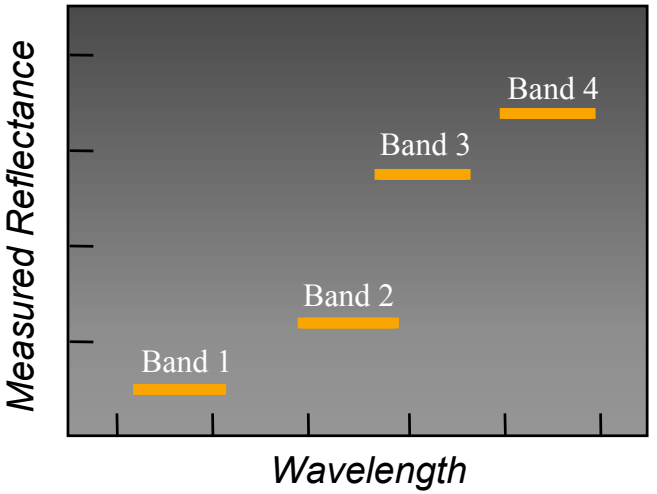
Hyperspectral and Multispectral Scene Characterization

June 4, 2002

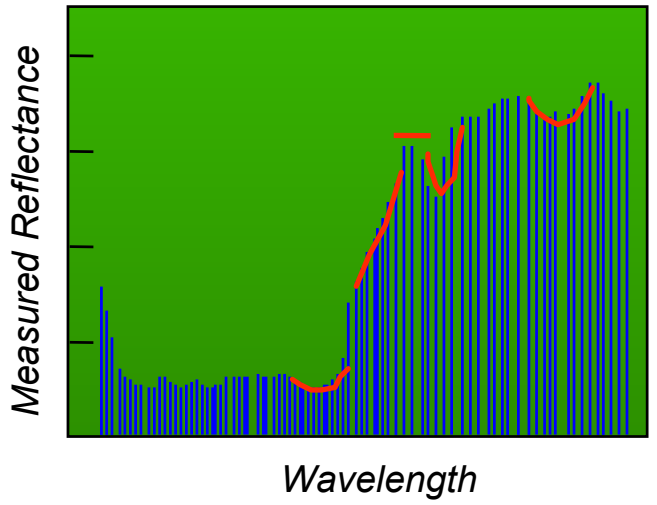
Hyperspectral Imaging
Hundreds of bands

Spectral characteristic of scene

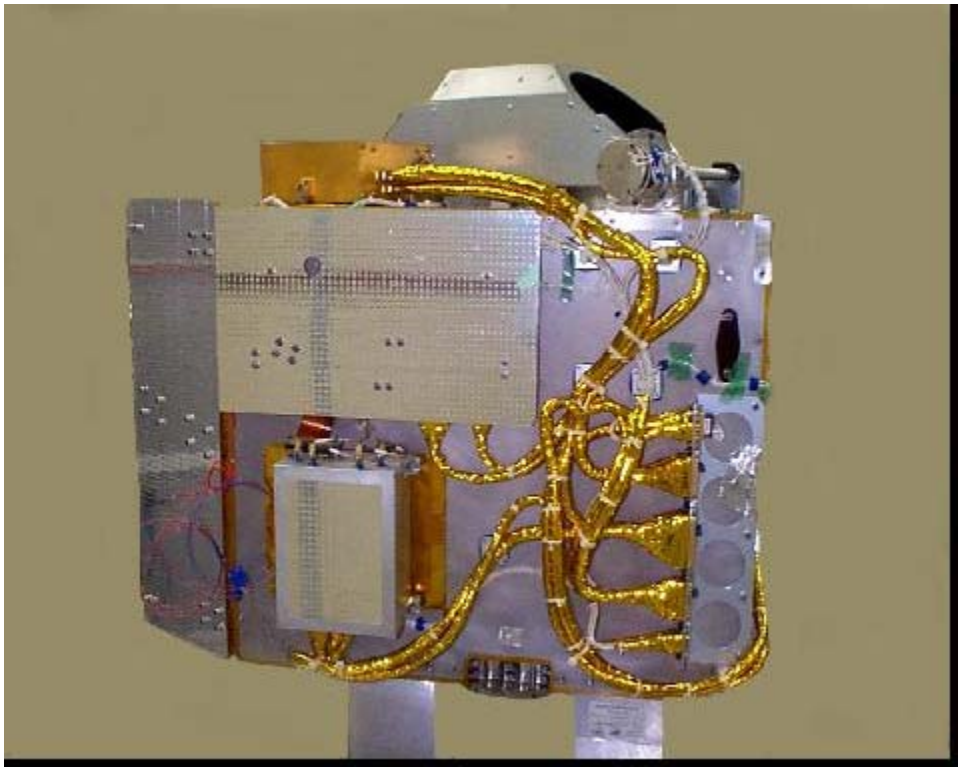




Multispectral Imaging
Few bands

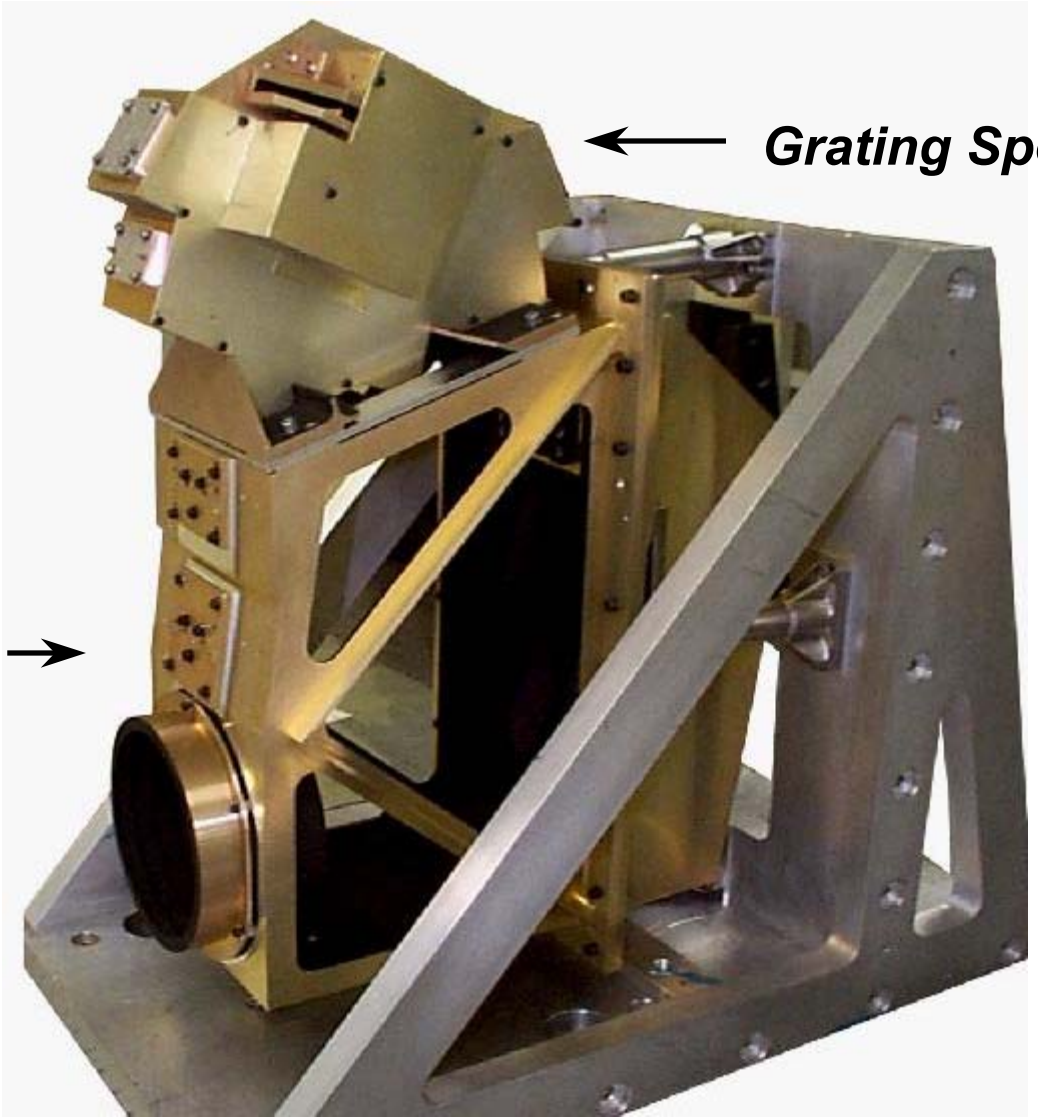


Hyperion Imaging Spectrometer

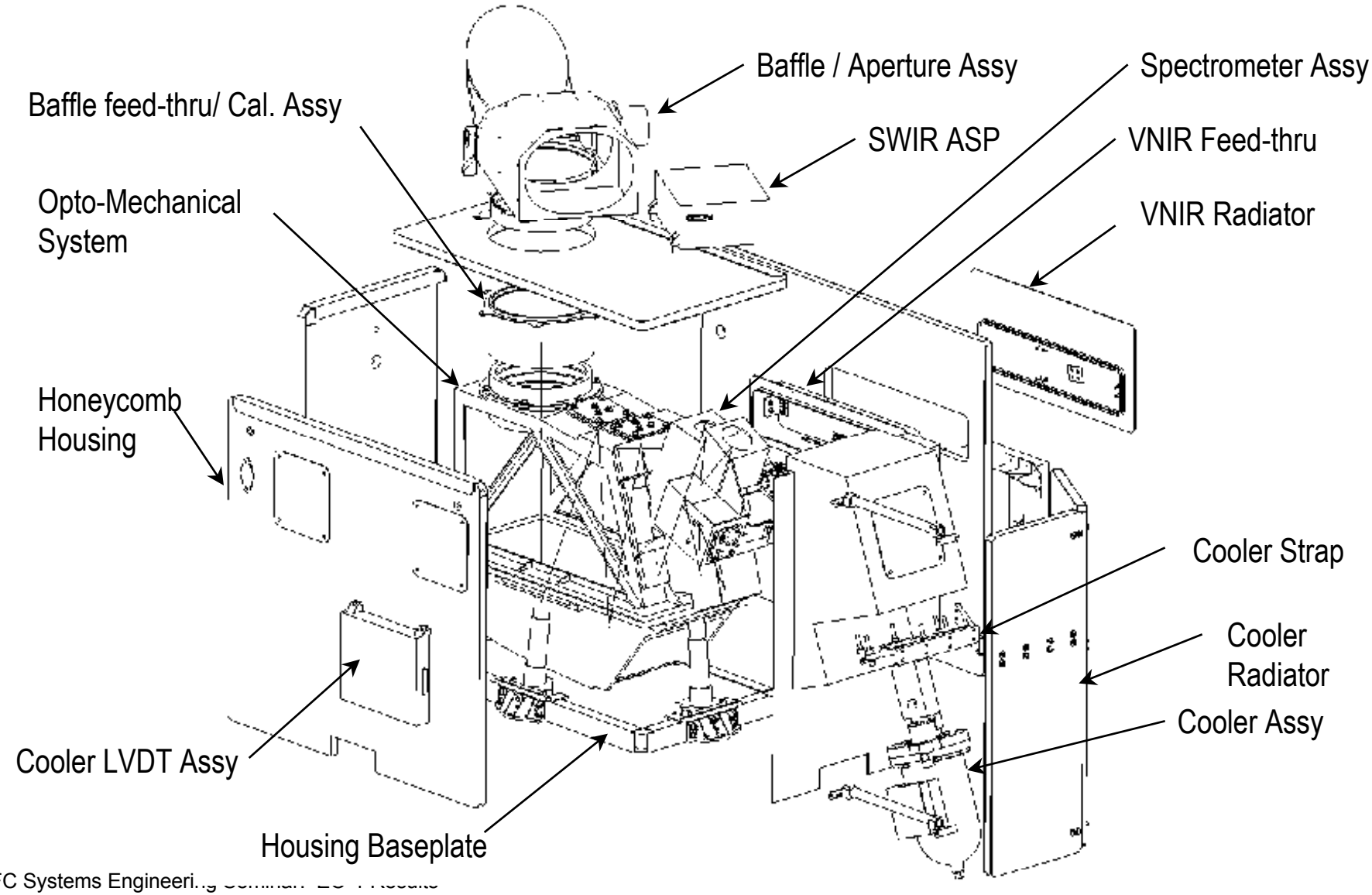


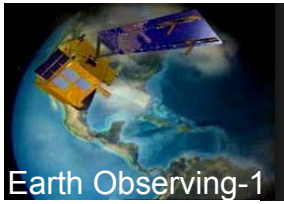
- ***Twin Convex Grating spectrometers with CCD VNIR and HgCdTe SWIR detectors***
- ***30m spatial and 10nm spectral resolutions over 7.5km swath and 400-2500nm spectral range***
- ***Multiple calibration options: lamps, lunar, solar, ground imaging and laboratory***
- ***Hyperspectral Imaging Capability to address Earth Observation applications***

Hyperion Optical System



Hyperion Sensor Assembly Components





Hyperion Performance Requirements

June 4, 2002

Instrument Parameter	Requirement
GSD at 705 km Altitude	30 +/- 1 m
Swath Width (km)	7.5 km minimum
Spectral Coverage	0.4 - 2.5 μm
Imaging Aperture	12.5 +/- 0.1 cm diameter
On-orbit Life	1 year (2 years goal)
Instantaneous Field of View	42.5 +/- 3.0 μrad
Number of Spectral Channels	220 minimum
SWIR Spectral Bandwidth	10 +/- 0.1 nm
VNIR Spectral Bandwidth	10 +/- 0.1 nm
Cross-track Spectral Error	<1.5 nm (VNIR), <2.5 nm (SWIR)
Spatial Co-registration	<20% of Pixel
Absolute Radiometric Accuracy	<6% (1 sigma)
Data Quantization	12-bit
Operability (SWIR, VNIR)	> 98% each*

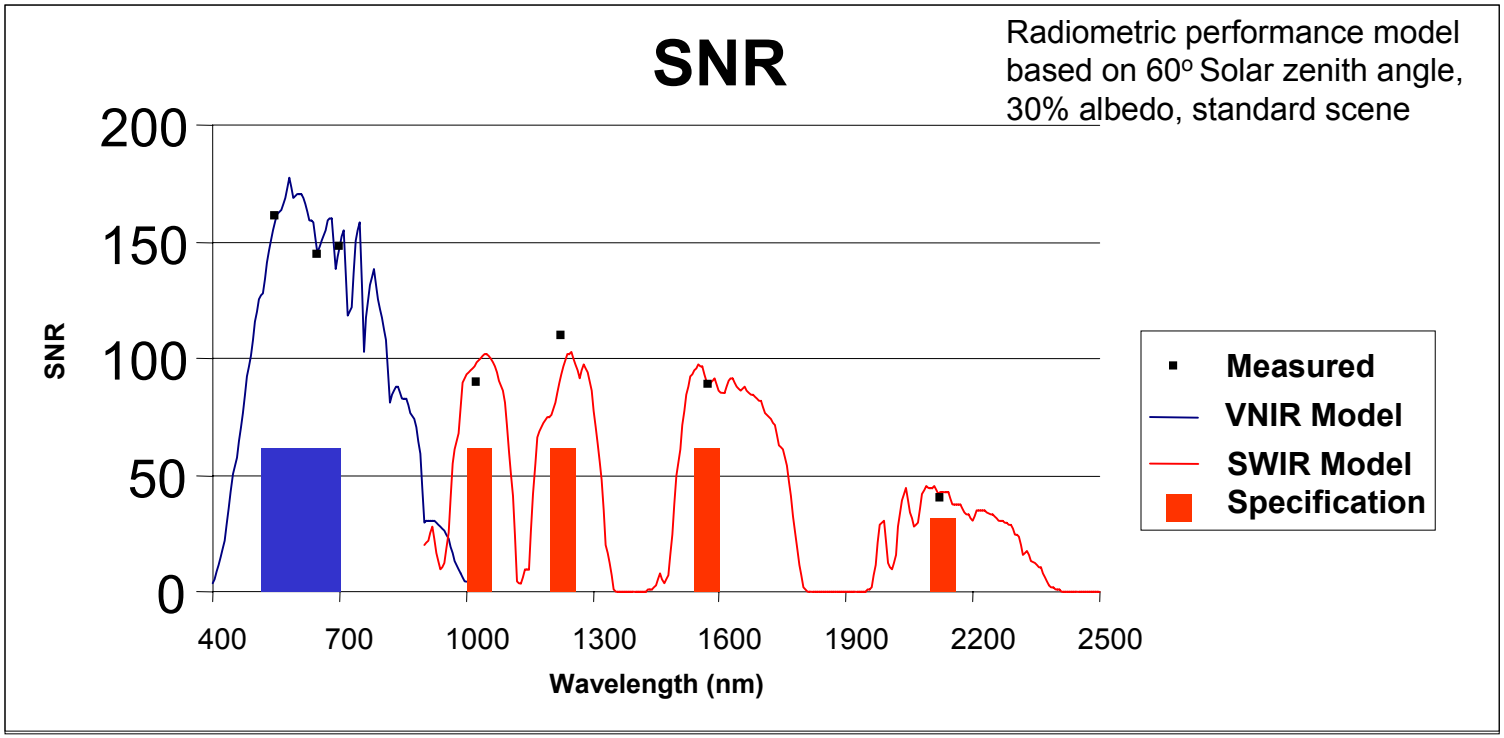
Signal to Noise Ratio (SNR)

λ-range (μm)	SNR (min)
0.55-0.70	60
1.0-1.05	60
1.20-1.25	60
1.55-1.60	60
2.10-2.15	30

Modulation Transfer Function (MTF)

	VNIR MTF @ 8.33 l/mm			SWIR MTF @ 8.33 l/mm			
Wavelength (μm)	0.45	0.63	0.90	1.05	1.25	1.65	2.20
Minimum MTF Requirement	0.20	0.20	0.15	0.14	0.14	0.15	0.15

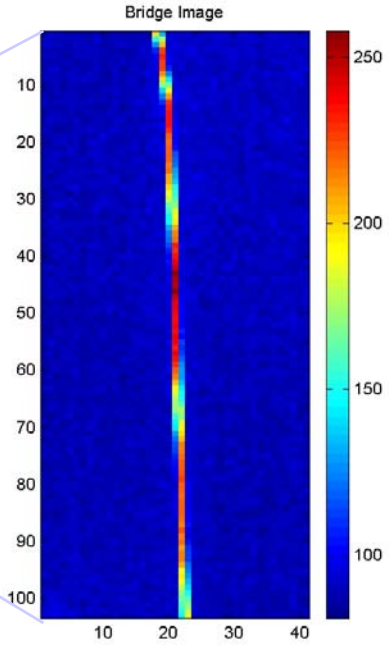
Hyperion SNR

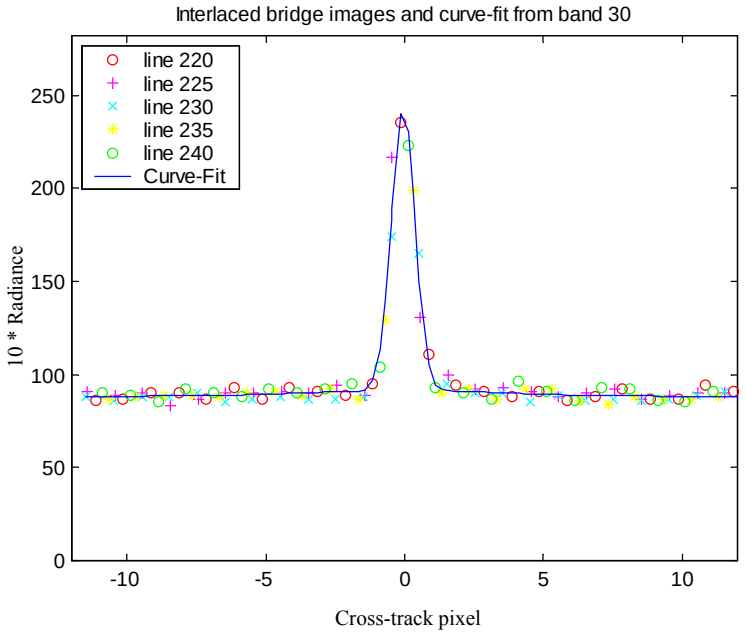


Hyperion Measured SNR						
550 nm	650 nm	700 nm	1025 nm	1225 nm	1575 nm	2125 nm
161	144	147	90	110	89	40

MTF Example: Cross-Track Bridge

- ***Port Eglin, Dec 24, 2000. Bridge is the Mid-bay bridge near Destin, Florida.***
- ***Bridge width (13.02 m) acquired and utilized in the MTF processing.***
- ***Bridge angle small, every 5th line used to develop high resolution bridge image.***
- ***MTF result at Nyquist is between 0.39 to 0.42 while the pre-flight measurement was 0.42.***





Hyperion Addresses Imaging Spectrometer Capabilities Around the World

June 4, 2002

Forests

Canada

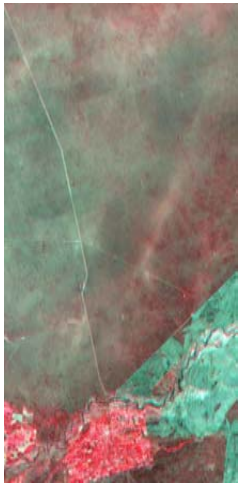
Agriculture

Australia

Minerals

United States

Grasslands



Argentina

Glaciers

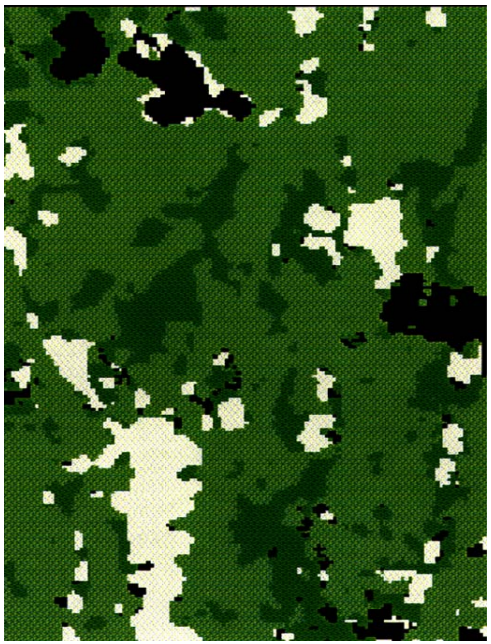
Antarctica

Deserts

Sahara

Hyperspectral Image Provides Forestry Detail

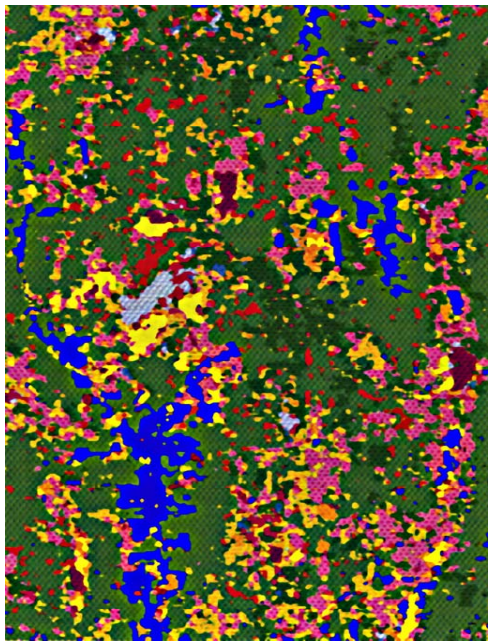
LandSat Analysis



Legend

- No Data
- Hardwood
- Softwood
- Grass / Fields

Hyperspectral Analysis



Legend

- No Data / Open field
- Hemlock/ Hardwood Mix
- Red Maple
- Mixed Conifer
- Red Oak
- Norway Spruce
- Mixed Hardwood
- Red Pine
- Hardwood/ Conifer Mix
- Spruce Swamp
- White Pine
- Hardwood Bog

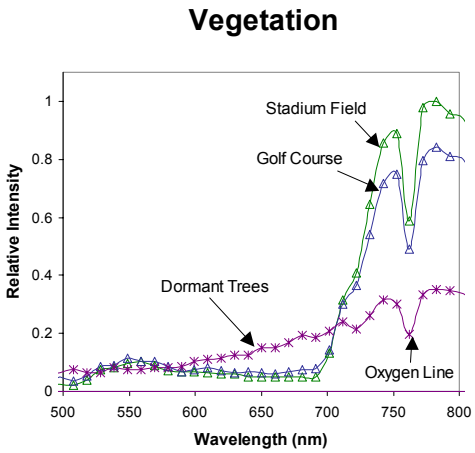
Analysis by Mary Martin University of New Hampshire

Hyperion Image

June 4, 2002

Image taken near Washington DC (Fairfax, VA) on Friday December 1, 2000

This image, taken by the Hyperion Imaging Spectrometer on EO-1, reveals the relative chlorophyll content of vegetation in an area of Fairfax County, Va. The spectral profiles indicate healthy grass in the stadium field and golf course. The spectral profile of the trees indicates dormant vegetation.

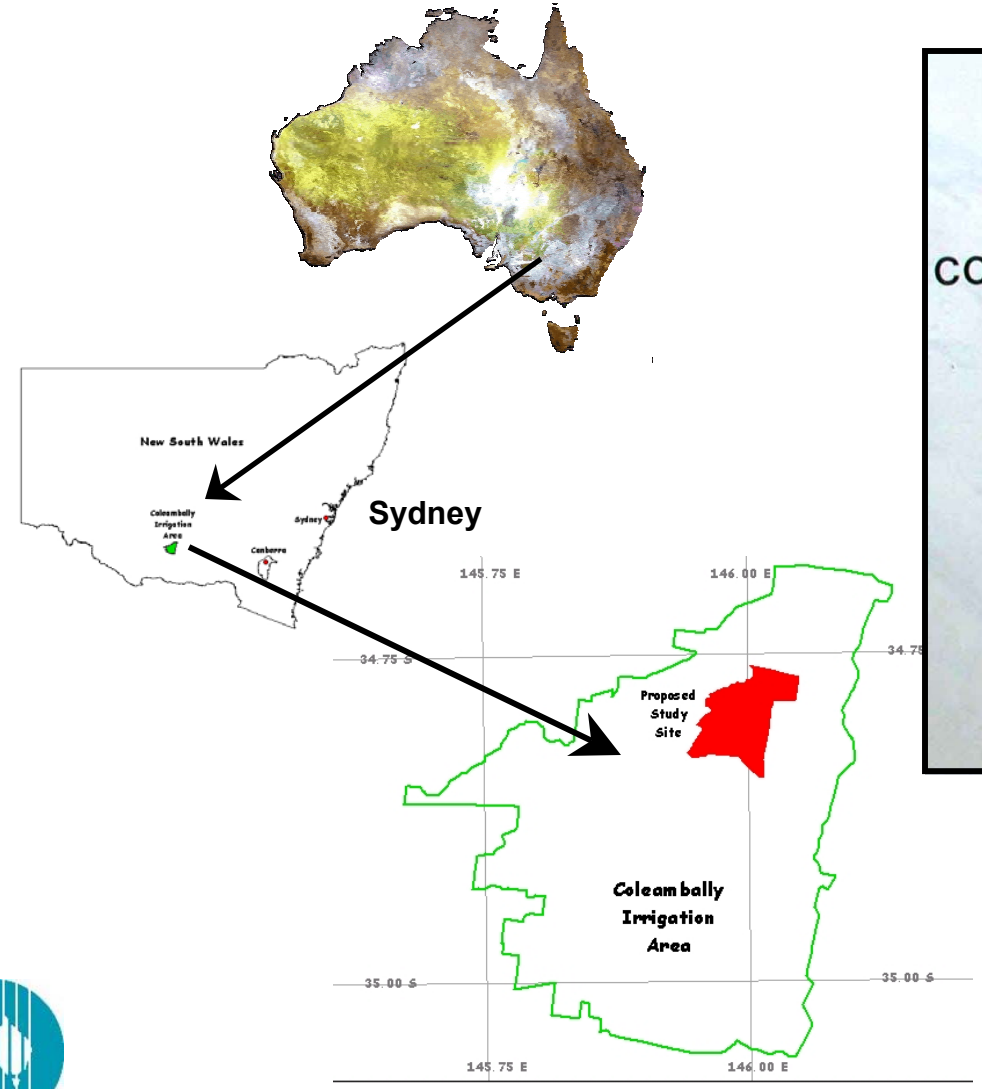


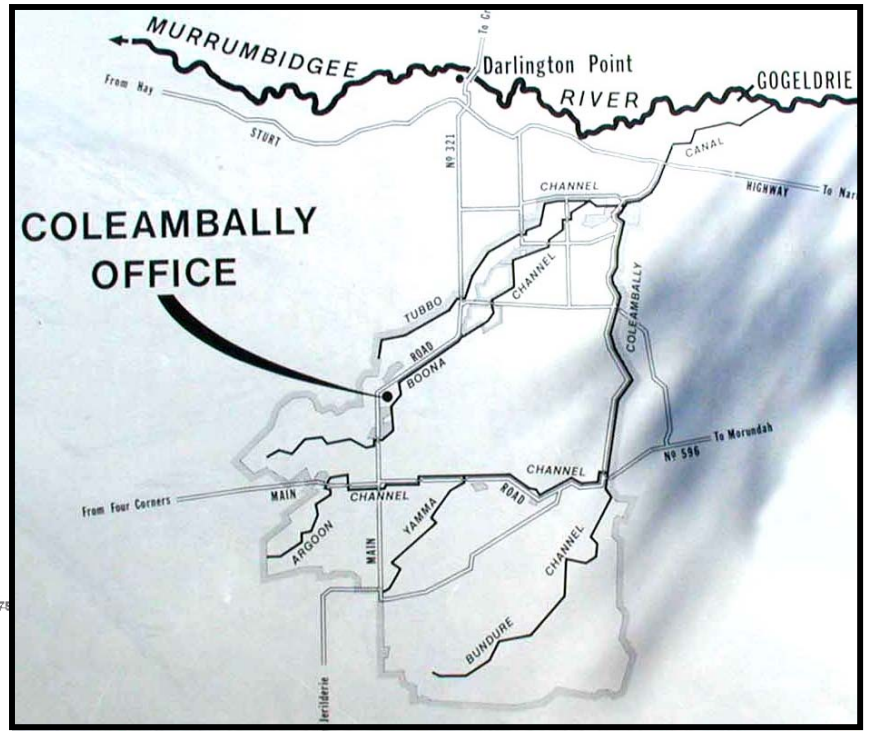
Oxygen in the atmosphere is detected at near infrared wavelengths in the spectral profiles.

Courtesy of TRW Inc.

Coleambally Irrigation Area
NSW, Australia

June 4, 2002





CIA covers 300 sq. miles including 312 large irrigated farms

Coleambally Land cover

Riverbed

Brush

Paddock – Planted

Main Road

Bare Soil

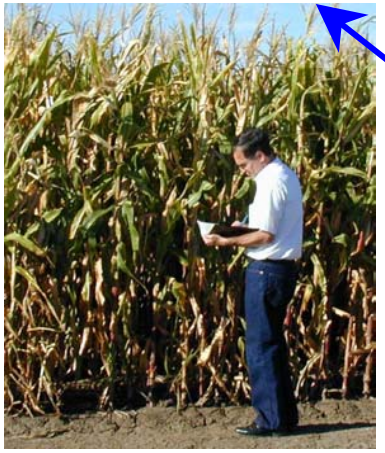
"Dirt Road"

VNIR Example: Agricultural Land Cover (Coleambally Irrigation Area)

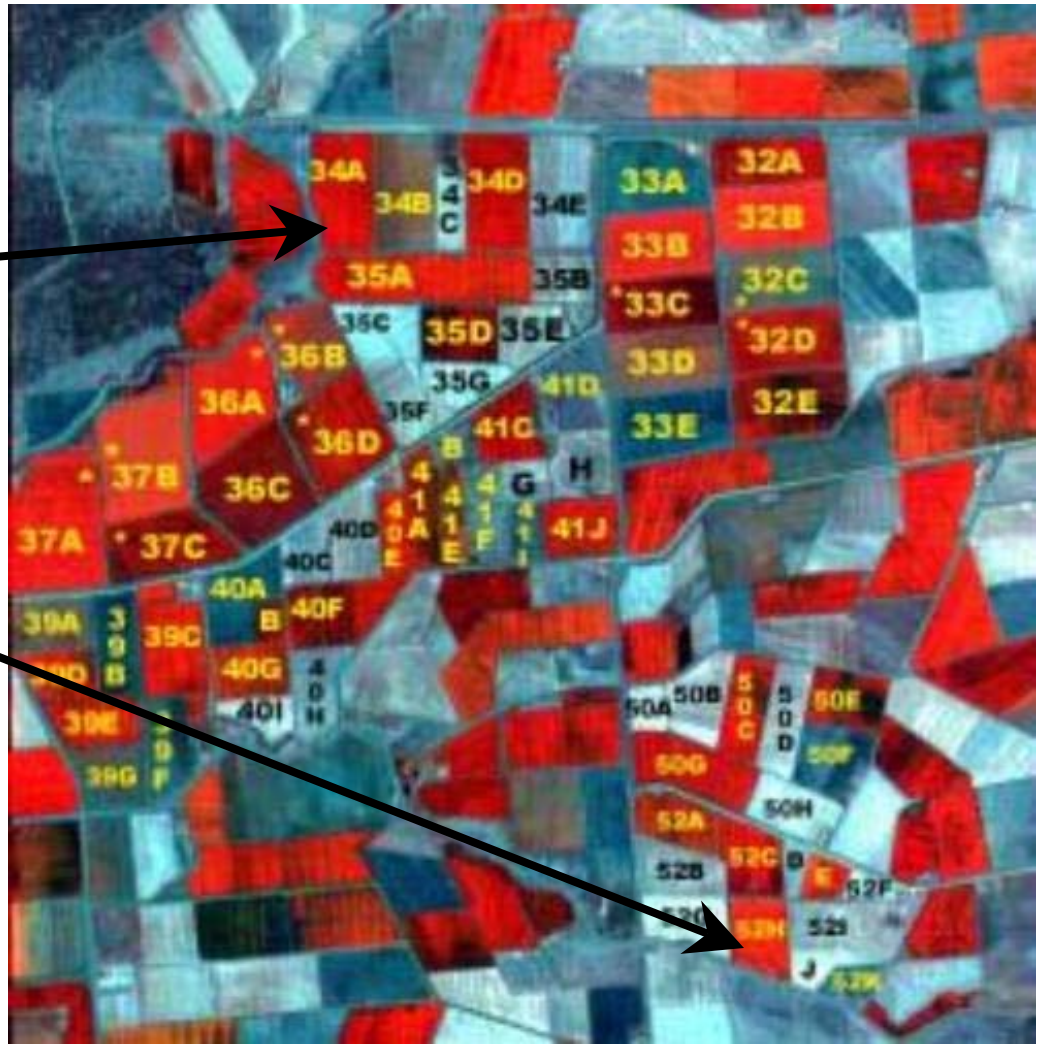
Soybeans

Rice

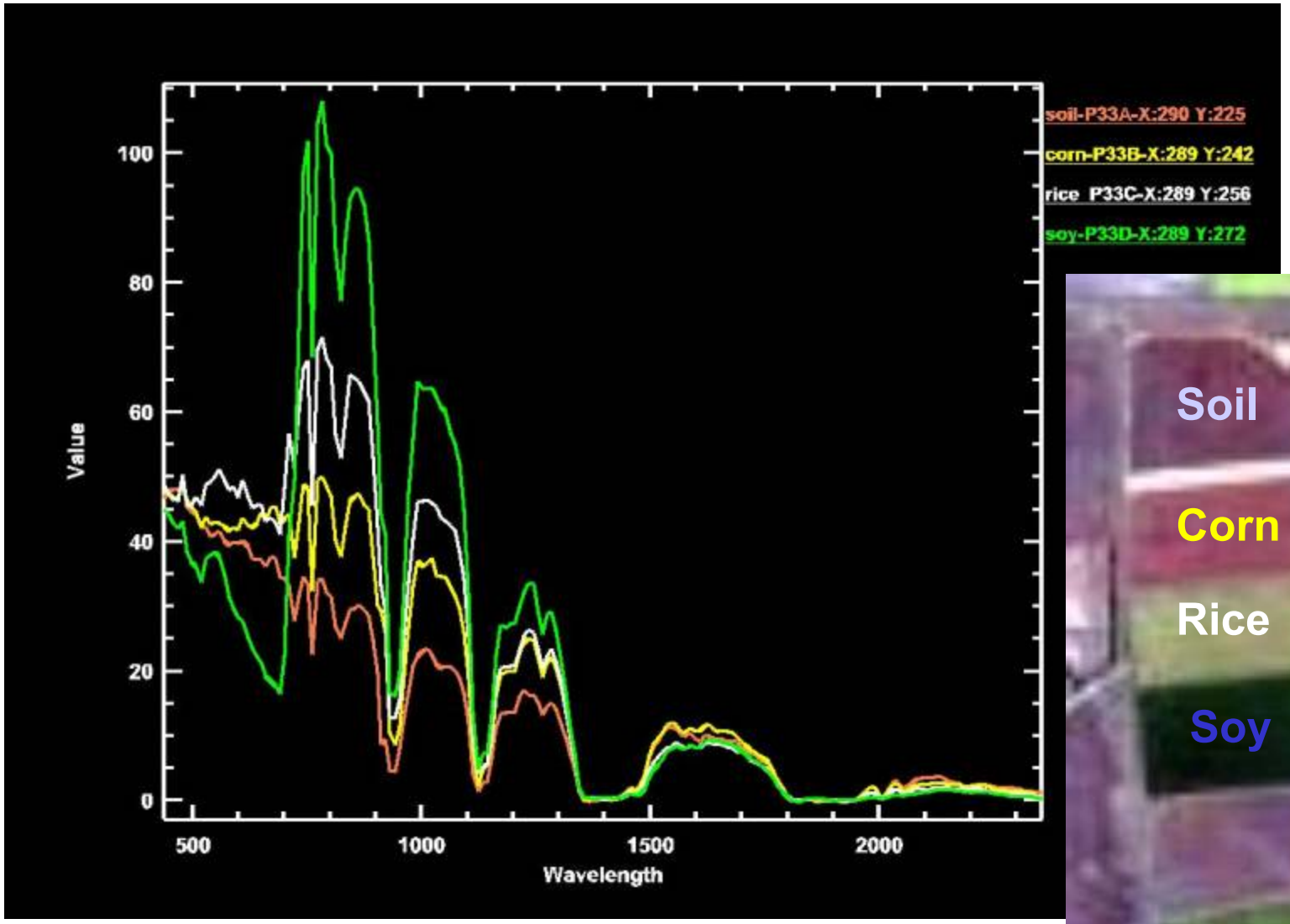
Corn



Paddock References



Spectral Signatures (Paddock 33-3/7/01)

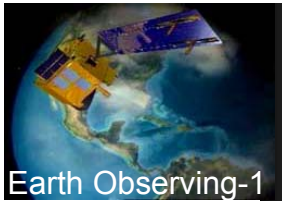


CSIRO

Coleambally

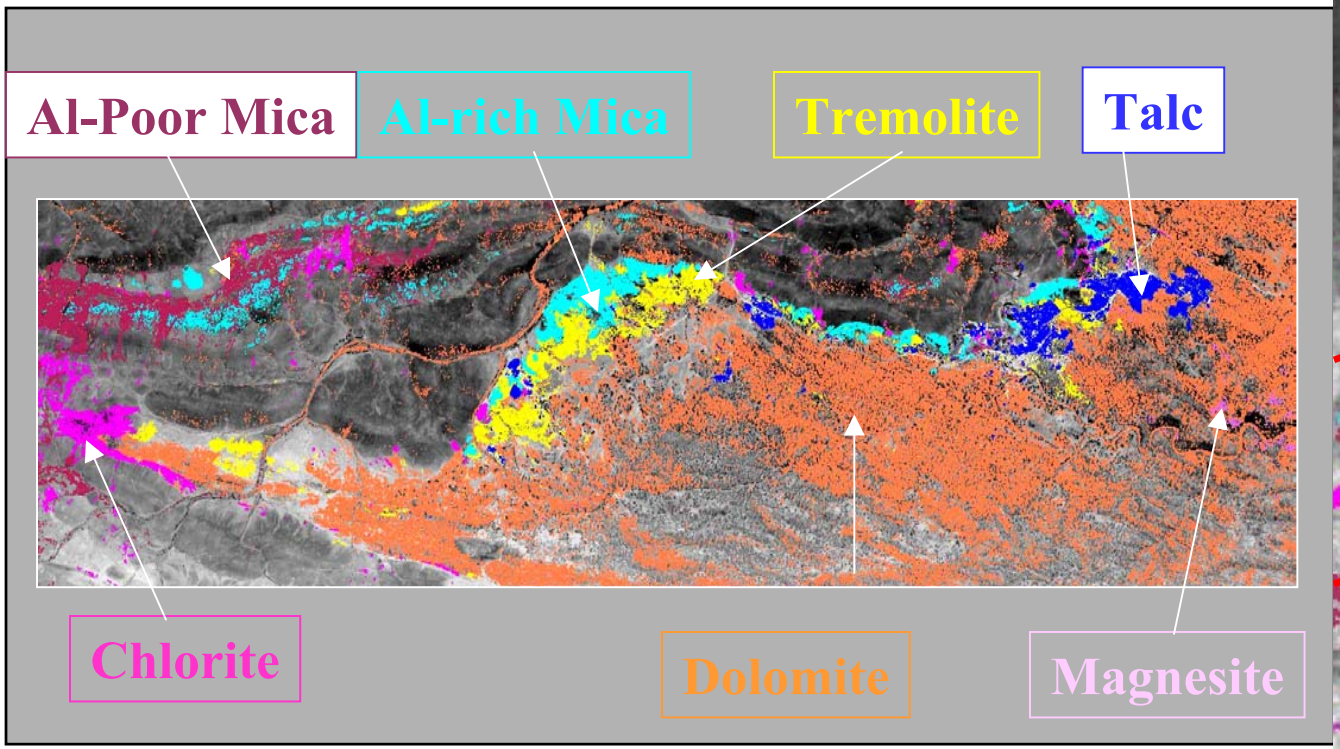
Mt Fitton Advanced Analysis

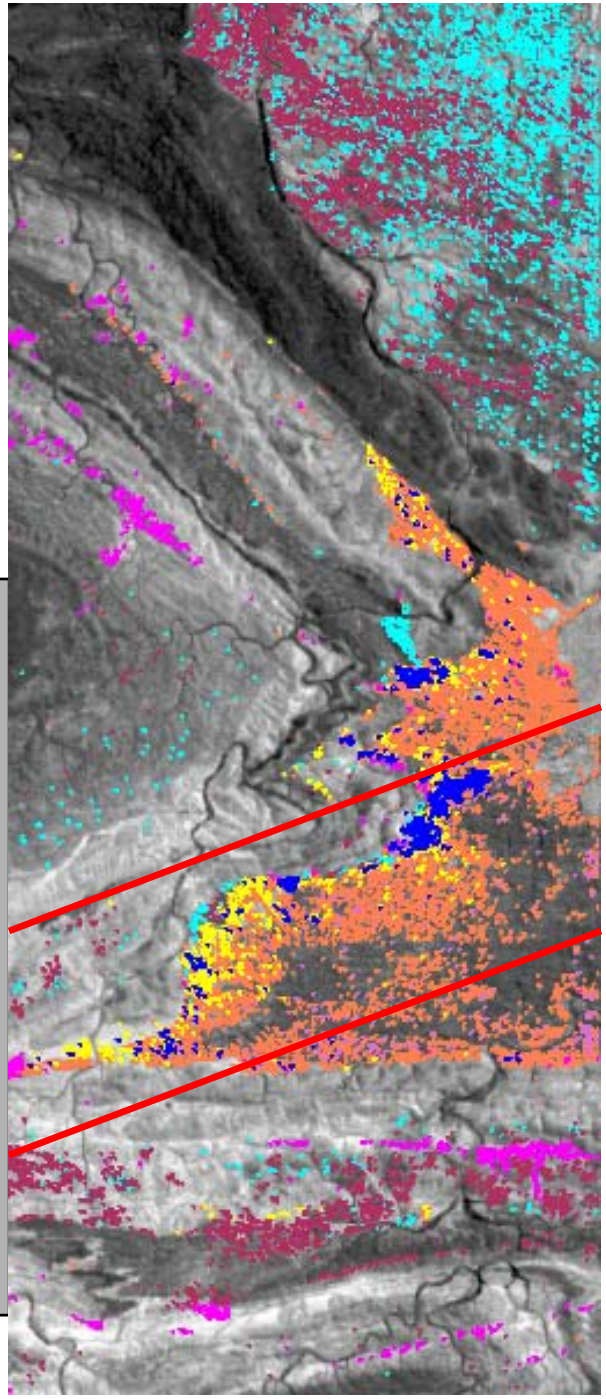
- ***Mt Fitton, South Australia***
  - ***Semi-arid (<250 mm per year)***
  - ***Sheep (wool) and mining (talc)***
  - ***-29°55'S, 139° 25'E 700 km NNW of Adelaide***
- ***T.J. Cudahy, R. Hewson, J.F. Huntington, M.A. Quigley, CSIRO Exploration and Mining***



Hyperion vs. HyMap Mineral Maps

CSIRO Exploration and Mining



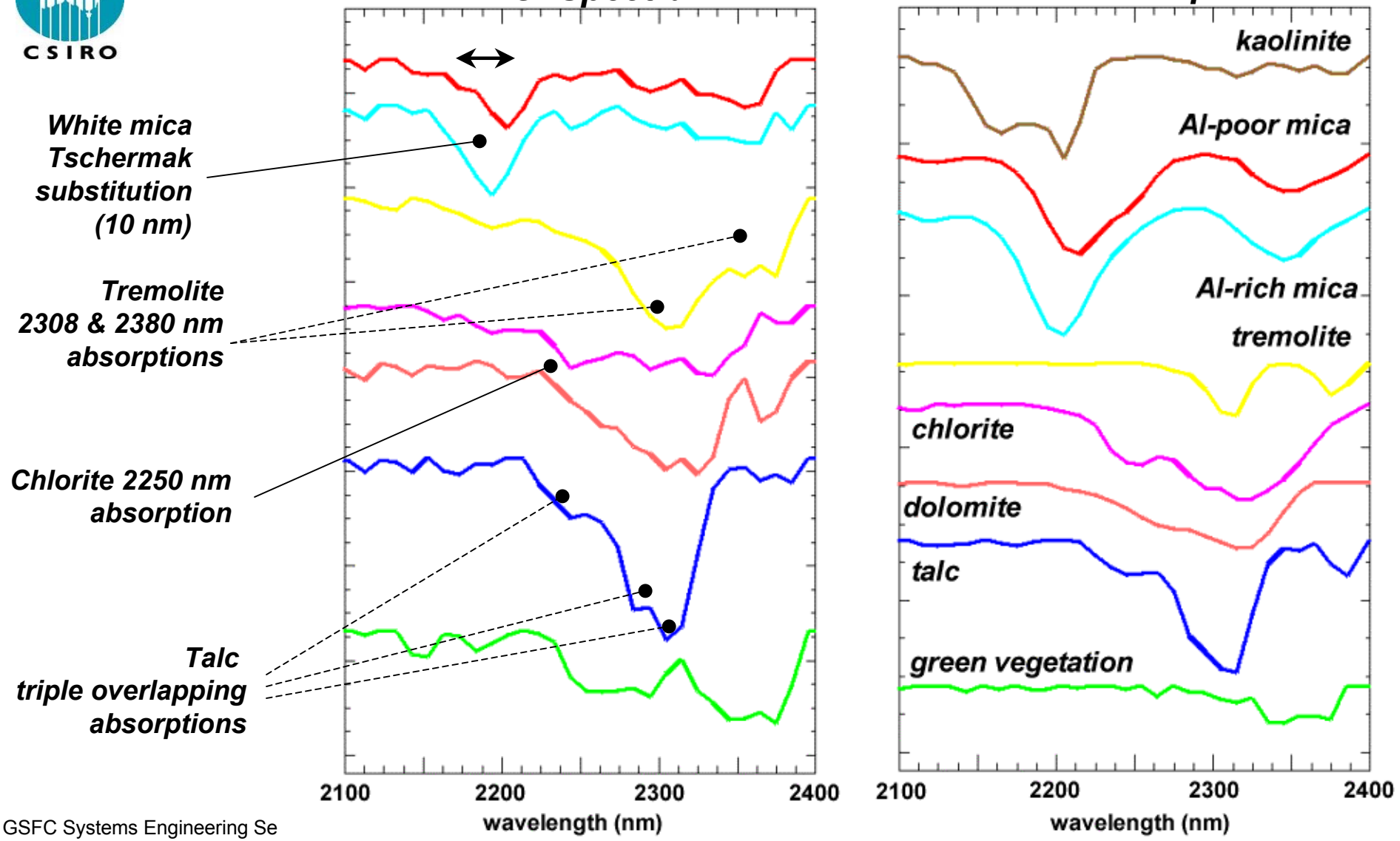


SWIR Spectrum

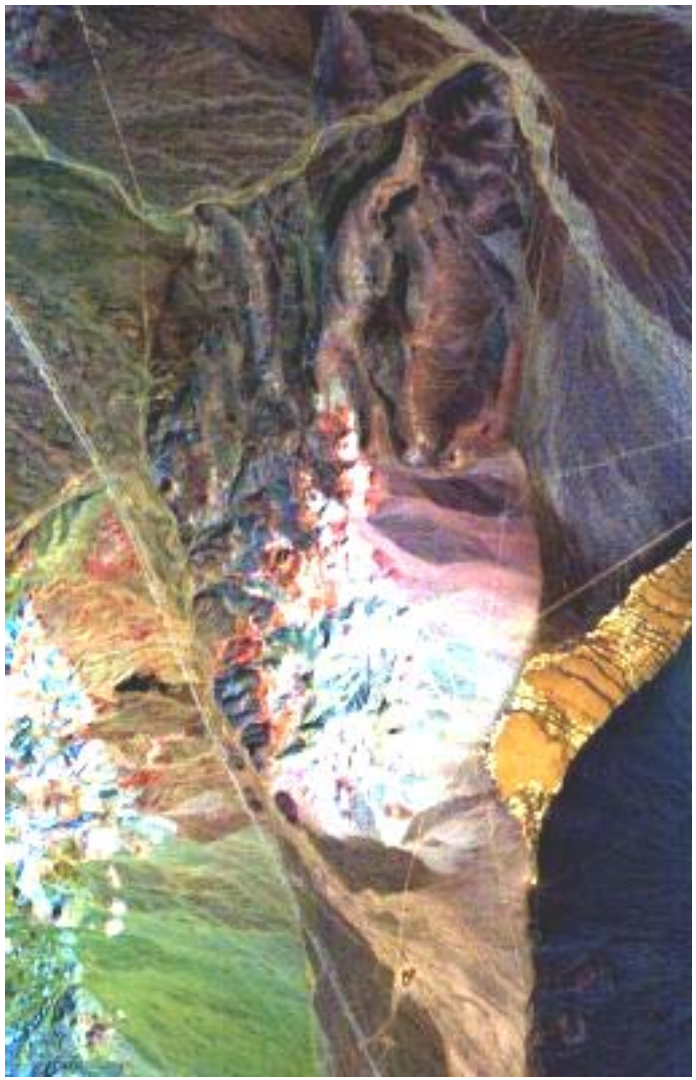
CSIRO

Reduced Hyperion ROI Spectra

USGS Laboratory Convolved Spectra



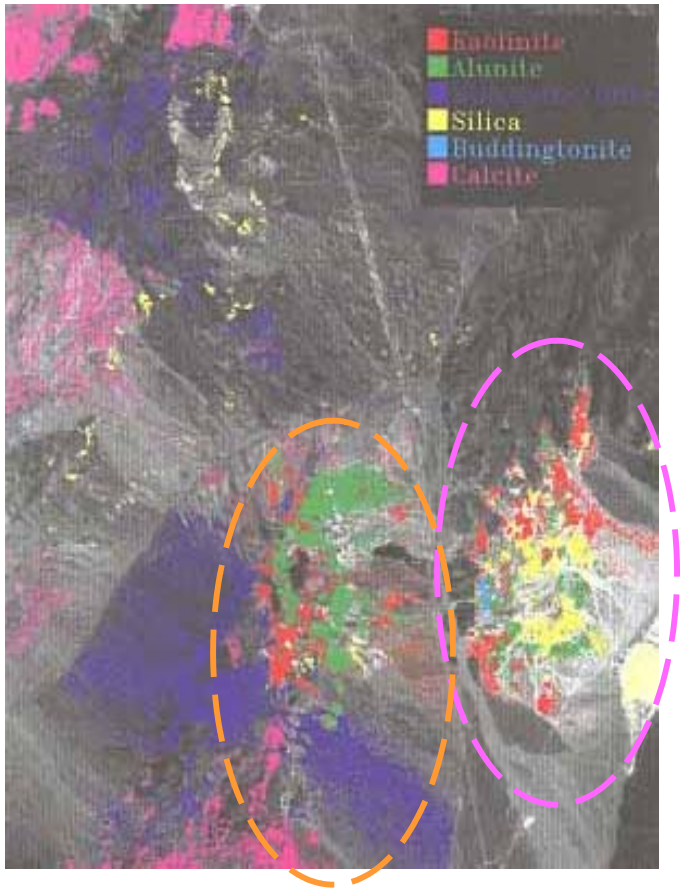
Reference Site: Cuprite



Hyperion True Color Image

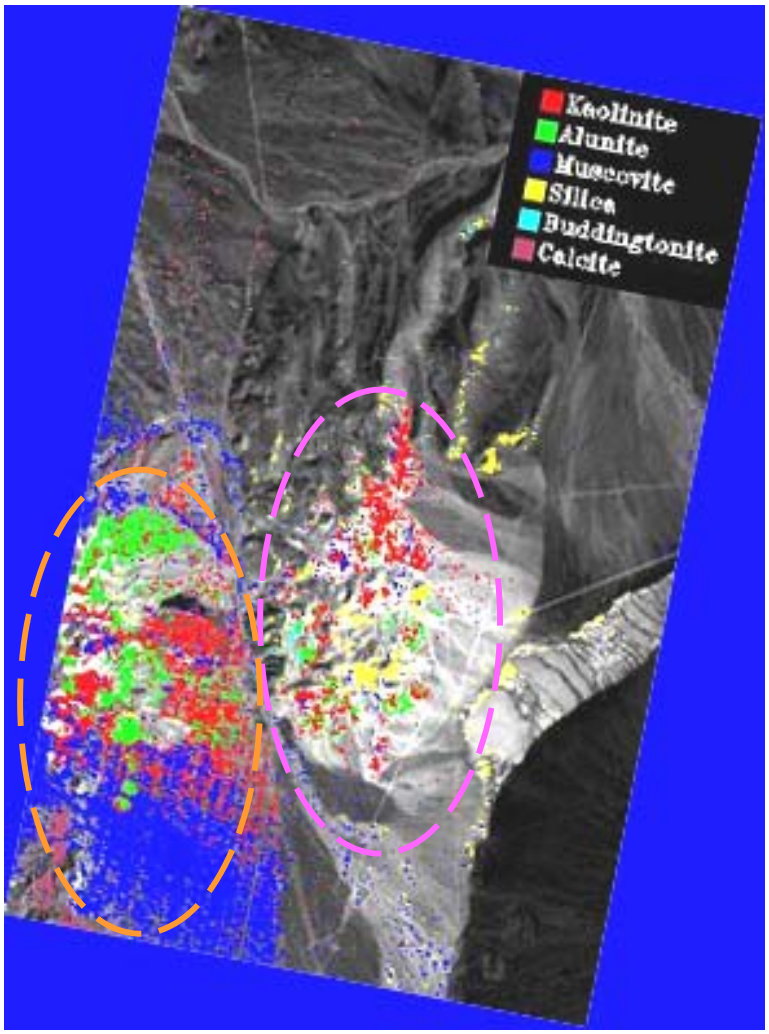
- ***Reference Site used to evaluate Remote Sensing Instruments (Airborne and Spaceborne):***
  - *AVIRIS (http://speclab.cr.usgs.gov/cuprite.html) (Airborne Visual and Infra-Red Imaging Spectrometer)*
  - *SFSI (http://www.borstad.com/papers/) (SWIR Full Spectrum Imager)*
  - *Landsat ETM+ (http://edcdaac.usgs.gov/samples/)*
- ***Located in arid and sparsely vegetated region along the California/Nevada border near Death Valley***
- ***Geology dominated by siliceous to basic volcanic rocks of Tertiary age***

Remotely Sensed Map: Hyperion & AVIRIS



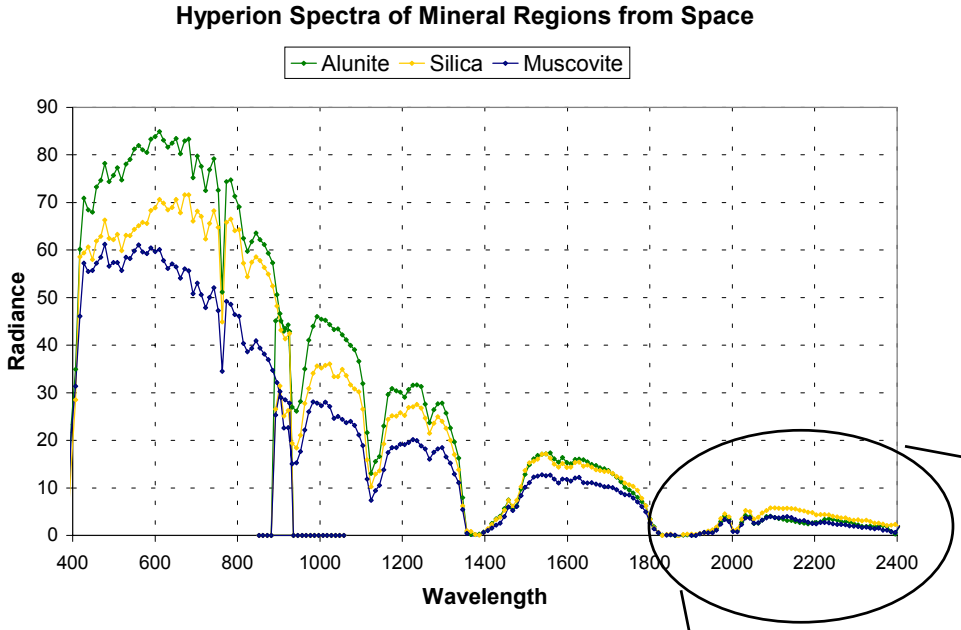
July 1995
AVIRIS Mineral Map

Courtesy of Fred Kruse AIGLLC



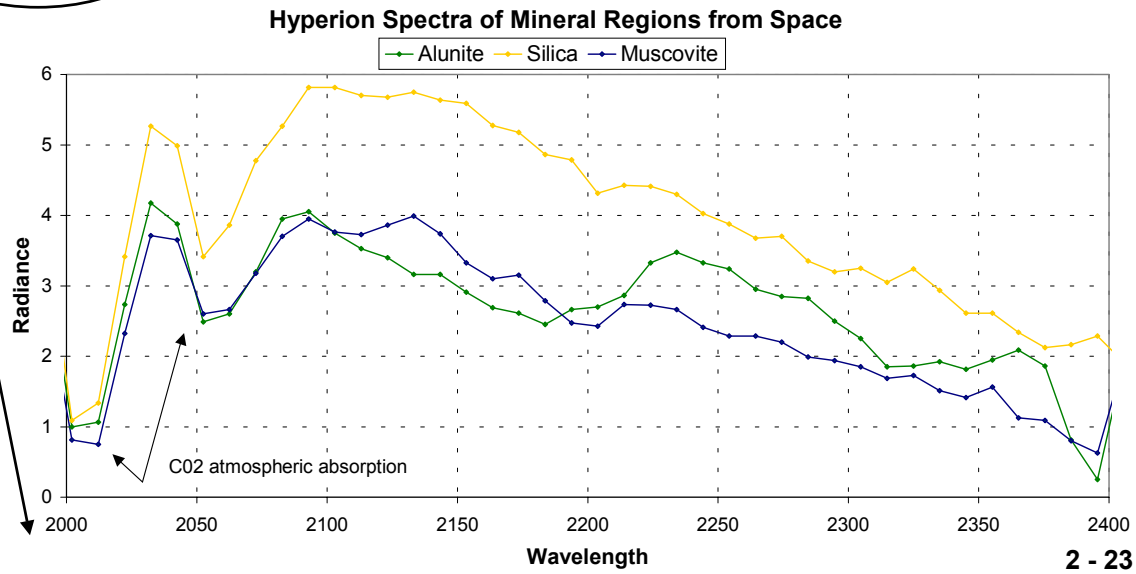
March 2001
Hyperion Mineral Map – 30 m resolution

SWIR Spectra used for Mineral Map



Spectral signature is a combination of the solar irradiance profile, reflectance and atmospheric absorption

Mineral map based on the far region in the SWIR.



This region has the lowest signal level and the lowest SNR.

Slight variations in the spectra are used.